Santos T, Gomes M I, Coelho F, Faria P (2019) "Earth-based and current plasters: assessment of efficiency and contribution to indoor air quality", in: 5th Historic Mortars Conference, Proceedings PRO 130, Álvarez JI, Fernández JM, Navarro Í, Durán A, Sirera R (ed.), 5-20, 19-21 June 2019, Pamplona, Spain, RILEM Publications S.A.R.L., Paris, France, ISBN: 978-2-35158-221-3

Earth-based and current plasters: assessment of efficiency and contribution to indoor air quality

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Abstract

Indoor air quality is very important for comfort but also for buildings inhabitant's health, since poor indoor air quality can lead to adverse health effects, like allergies and chronic diseases such as asthma. Therefore it is considered that is extremely important to understand if plasters have the ability to capture indoor pollutants and contribute to the regulation of indoor air quality. In the present study, five different plasters are analysed to compare the behaviour of earth-based plasters with commonly used plasters. Before assessing the contribution of plasters to the capture of pollutants, it is necessary to characterize the m. It is possible to conclude that the addition of air lime to an earth plastering mortar decrease mechanical strength and hygroscopic capacity. Earth plasters show high sorption and desorption capacity when compared to commonly used plasters, such as cement and gypsum-based. The lower sorption capacity of plasters with current binders may induce a lower air pollutants capture capacity but that still needs to be tested.

Introduction

World Health Organization (WHO) estimates that 3.8 million annual causes of death are attributed to indoor air pollution from buildings [1]. Indoor air quality (IAQ) is very important for comfort but also for health of buildings inhabitants, since poor IAQ can have a high impact in health, comfort, well-being and cognitive performance of building occupants. Particularly long term exposure of building occupants to a poor quality indoor air can produce various symptoms in the buildings occupants, like fatigue, eye irritation, headaches, dizziness, skin irritation, chronic problems, among others [2]. It is important to emphasize that people spend much of their time inside buildings. Currently, around 50 % of the world's population lives in cities and about 80 – 90 % of their lives is spent inside the buildings (home, work and leisure) [3–5]. For this reason, the IAQ is a major issue not only for new construction but also for the conservation of old buildings. Therefore, it is necessary to consider the materials that are used inside the buildings and, above all, analyse its contribution to improve IAQ.

There is a lot of tradition on cement-based construction around the world; cement is the second most consumed substance in the world by weight [2] and widely used in interior finishes, such as cement plastering mortars. However, it is known that about 900 kg of CO_2 are emitted into the atmosphere during the production of 1 ton of cement [2]. Given these facts, whenever possible, it is very important to use environmentally friendly building materials – ecological, sustainable, with lower CO_2 emissions – and materials that may also contribute to improve IAQ of buildings.

Earthen mortars present several advantages: the raw material is natural, non-toxic, low costly, involving low CO_2 emissions to be applied as a building material, with low embodied energy, reusable (when not chemically stabilized). Through the hygroscopic capacity of clays, earth plasters have a high capacity to adsorb and release water vapour, contributing to balance indoor relative humidity (RH) and temperature, promoting the comfort of the occupants and indoor air quality [6–15]. The interest of the scientific community by earth plasters has emerged in the last decade. But earth plasters characteristics are not often tested in comparison with common plasters. With regard to earth plasters pollutants absorption capacity, no study has yet been carried out to prove this capability. However, there are already some advances in this area regarding cement mortars [2].

In order to improve IAQ, it is extremely important to understand the relationship between indoor air pollutants and the ability of a plaster system, based on mortars, to capture these pollutants and contribute to the regulation of temperature, RH and, consequently, IAQ. Before understanding the contribution of plasters to pollutants capture, it is necessary to characterize them physically and mechanically. In consequence, in the present study the physical and mechanical characteristics of three earth-based plastering mortars are evaluated – a pre-mixed earth plastering mortar, a laboratory formulated earth mortar and a pre-mixed earth-air lime plastering mortar –, in comparison to two pre-mixed plastering mortars commonly used in Portugal, one based on hemi-hydrated gypsum and the other on cement. Mortars are characterized in the fresh and hardened states, in terms of bulk density, mechanical strength, capillary, drying, sorption and desorption.

Materials and methods

Characterization of materials

In the present study five different plastering mortars are analysed: a pre-mixed earth mortar with natural fibres (T_E), produced by Embarro; an earth mortar formulated in laboratory (T_AP), with a red clayish earth (RCE), fine (FS) and (CS) coarse sands; a pre-mixed earth-air lime mortar (T+CL), produced by Aldeias de Pedra company; a pre-mixed cement mortar (C) – RHP Manual Interior –, produced by Secil Argamassas company; and a pre-mixed gypsum mortar including a finishing coat (G) – Project 2010 and Massa de Acabamento –, produced by Sival company.

The T_E mortar is composed by a clayish earth, from Algarve region, fine sand with particle size distribution of 0 – 2 mm and straw fibres cut with less than 10 mm in length. Other researchers analysed a similar pre-mixed earth mortar from the same producer and concluded that this mortar was produced with an ilitic clay [16–18]. The proportions of each constituent of this mortar are not exactly known. The T_AP mortar was formulated in laboratory conditions and was produced with volumetric ratio of 1:3:1.5 and mass ratio of 1:3.04:1.78 (RCE:FS:CS). The T+CL mortar is composed with yellow clayish earth (YCE), provided by Sorgila, coarse sand (CS), limestone powder (LP) and an addition of air lime putty (ALP). The exact proportions of each constituent are not known. The same happens with cement (C) and gypsum-based (G) mortars, since these are already marketed as pre-mixed.

The loose bulk density of the materials were analysed by EN 1097-3 [19], taking an average of three specimens of each material and can be seen in Table 1. Particle size distribution of the materials were performed by EN 1015-1 [20]. The wet method was used for the clayish earths (RCE and YCE), pre-mixed earth mortar product (T_E) and limestone powder (LP). The dry method was used for fine and coarse sands (FS and CS). To complement the particle size distribution of RCE, YCE, T_E and LP materials, since these materials presents particles lower than 0.075 mm, the sedimentation was also analysed, according to LNEC specification E196 [21]. From the particle size distribution of the materials present on T_AP mortar (RCE, FS and CS) it was possible to determine its particle size distribution. The results are shown in Figure 1. According to the producer's indication, the cement-based mortar present particle size lower than 1.2 mm, by EN 1015-1 [20].

Table 1. Loose bulk density of the materials

Material	**Loose bulk density [kg/dm^3]**
Pre-mixed earth mortar (T_E)	1.40 ± 0.01
Red clayish earth (RCE)	1.36 ± 0.01
Yellow clayish earth (YCE)	1.20 ± 0.00
Limestone powder (LP)	1.37 ± 0.02
Fine sand (FS)	1.38 ± 0.00
Coarse sand (CS)	1.61 ± 0.00
Pre-mixed cement mortar (C)	1.50 ± 0.00
Pre-mixed gypsum mortar (G)	0.81 ± 0.01

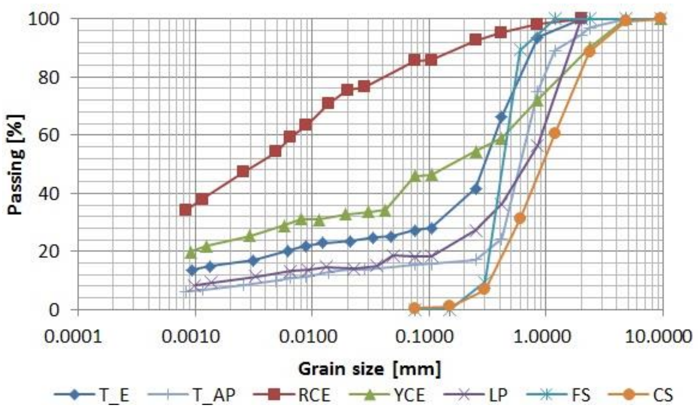

Figure 1. Particle size distribution of the materials (T_E, RCE, YCE and LP by wet method and sedimentation, and by dry method for FS and CS) and T_AP mortar.

Mortars and specimens

The pre-mixed earth, earth with air lime putty and cement mortars (T_E, T+CL and C) were produced only by addition of the water content indicated by each producer (15 %, 20 % and 14 %, respectively). Due to lack of indication from the producers, for T_AP and G mortars a water content was defined (10 % and 43 %, respectively) by an experienced craftsman to assure good workability.

In order to reproduce, as much as possible, the method carried out on construction site, all mortars were produced using a mixer blade (Figure 2a). Dry materials were placed in a bucket and the water was slowly added. An initial mixture of 8 minutes was carried out; after this period, the mortar that adhered to the bucket edges was removed and added to the remaining mortar, followed by a further 3 minutes of mixing (Figure 2a). This was considered time enough for the mortars to be homogeneous. The T+CL mortar was produced the day before of their specimens were moulded. The remaining mortars were produced the same day of moulding. For each plastering mortar different types of specimens were produced in metallic moulds: six prismatic specimens with 40 mm x 40 mm x 160 mm (Figure 2b and Figure 2c), moulded in two layers mechanically compacted with 20 strokes each and manually levelled; three planar specimens with 200 mm x 500 mm x 15 mm (Figure 3), manually compacted and levelled.

(a)  (b)  (c) 

Figure 2. Production of the T_E mortar (a), prismatic specimens of T_AP and T+CL in the metallic moulds (b) and prismatic specimens of C mortar (c).

Figure 3.Finishing of planar specimen of T_AP plaster (a) and planar specimens of T+CL plaster (b) and planar specimens of G plaster(c).

The gypsum finishing coat was only applied, with 1 mm of thickness, to the G planar specimens. Only the prismatic specimens were demoulded when dried, after at least 7 days. All specimens were placed in laboratory conditions at 20 ± 2 ^{o}C and 65 ± 5 % prior to the characterization tests. The age of the specimens of each plastering mortar for each characterization test can be observed in Table 2. A longer aging of T+CL mortar was justified by the fact of being the only mortar with slow reaction due to carbonation. For this reason, the mechanical strength was only assessed after 4 months. Unstabilised earth mortars (T_E and T_AP) harden just by drying. Cement-based (C) and gypsum-based (G) mortars are known by their fast hardening reactions. Therefore these mortars were tested for strength after 2 months.

Table 2. Age of mortar specimens for each characterization test

Characterization test	**Age of specimens mortars (in days)**				
	T_E	**T_AP**	**T+CL**	**C**	**G**
Dry bulk density	28	41	111	40	33
Flexural and compressive strength	54	68	138	67	60
Capillary absorption	56	75	146	109	68
Drying	61	75	153	116	75
Sorption and desorption	118	124	194	138	131

Methods

There is no specific standardization for earthen mortars, except the German standard DIN 18947 [22], which refers to some European standard tests for masonry mortars and complementary ones. Due to the fragility of earth mortars in the presence of water and low mechanical strength, these mortars present constraints more stringent than cement or gypsum-based mortars. For this reason, some adjustments were necessary to be made on the test procedures. In order to obtain comparable results, the adjustments made to test the earthen mortars were also carried out for testing the remaining mortars.

Fresh state

All mortars were characterized in fresh state by flow table consistency, according to EN 1015-3 [23] and by wet bulk density, according to EN 1015-6 [24]. The results are the average of two measurements for each mortar.

Dry bulk density and strengths

Six prismatic specimens of each mortar were used to evaluate the dry bulk density and flexural and compressive strengths. The dry bulk density was geometrically determined by the ratio between the dry mass and the volume of each specimen, provided by an electronic digital scale with 0.001 g of precision and a digital calliper, according to the DIN 18947 [22] and EN 1015-10 [25]. The flexural and compressive strengths were determined by DIN 18947 [22] and EN 1015-11 [26], using a Zwick Rowell Z050 equipment, with load cells of 2 kN and velocity of 0.2 mm/min for flexural strength and 50 kN and velocity of 0.7 mm/min for compressive strength.

Capillary absorption and drying

The capillary absorption of the mortars were evaluated according to EN 15801 [27] and EN 1015-18 [28]. Six cubic specimens with 40 mm x 40 mm x 40 mm were used, for each type of mortar. These specimens were cut from the prismatic specimens with a circular saw. The specimens were prepared according to the procedure used by Gomes et al. [29] for earth mortars: the lateral faces of the cubic specimens were waterproofed with a mixture of 50% of beeswax and 50% of pitch blond (mass proportions); the bottom face was covered with a cotton cloth; the specimens were placed in partial immersion, on a layer of 1 – 2 mm of water, on a saturated damp cloth with 5 mm of thickness, inside a box with a lid, which was only opened for weighing the specimens, to limit evaporation from the specimens. The test was carried out in controlled environment conditions of 20 ± 2^{o}C temperature and 65 ± 5 % RH.

The weight gain of the specimens over time was recorded. With these results the absorption curve of each mortar (the average of six specimens) was obtained with the amount of water absorbed per unit area (kg/m^2) as a function of the square root of the time (s$^{1/2}$). The capillary absorption test ended when the difference of the mass of water absorbed by the specimens between two successive weightings in 24 hours did not exceed 1 % [27]. The capillary water absorption coefficient (AC, in kg/(m^2.s$^{1/2}$)) is the slope of the linear section of the absorption curve and was calculated by linear regression using at least 5 successive aligned points [27].

For the drying test, according to EN 16322 [30], the same specimens used for the capillary absorption test were used. The drying test began immediately after the capillary test. The specimens were maintained under controlled environment conditions of 20 ± 2°C and 65 ± 5 % with only the top face exposed to the air, so that drying only occurs through that surface. The drying curve of the first phase of each mortar (the average of six specimens) was obtained with the amount of evaporated water (kg/m^2) – measured by periodical weightings – as function of the time (s). With this curve the drying rate in the first phase (D1, in $kg/m^2.h$) and the drying index (ID, dimensionless) [30] were determined. For determination of the drying rate of the second phase (D2, in $kg/m^2.h^{1/2}$), the drying curve obtained with the amount of evaporated water as a function of the square root of the time ($s^{1/2}$) was plotted.

Sorption and desorption

The sorption and desorption of the plasters were determined with three planar specimens in the metallic moulds of each plaster, according to DIN 18947 [22]. Therefore, only one face of the specimens was exposed. Initially the specimens were placed in the climatic chamber at 23 °C and 50 % RH for 24 hours, until constant mass (less than 2 % of variation). Then, the RH inside the climatic chamber was increased to 80 % (maintaining the temperature at 23 °C), starting the sorption phase of the plasters. The water vapour gain by the plasters, in g/m^2, was determined after 1, 3, 6, 12 and 24 hours, by weighing of the specimens using an electronic digital scale with 0.1 g of precision. Although DIN 18947 [22] reported a weighting in the first 30 min (0.5 hours), this was not performed, once this period (between the first 30 min until 1 hour) was considered too short to stabilize the climatic chamber and with negative influence on the test results at 1 hour of test. The DIN 18947 [22] also defines that the test ends after 12 hours. However, in this study the evaluation of the sorption was held up to 24 hours [10, 31, 32].

Although DIN 18947 [22] only requests the analysis of the sorption capacity of plasters, it was also considered important to evaluate their water vapour desorption capacity [10, 31, 32]. For that the reverse process was used. After 24 hours, the RH was changed to 50 % and the decrease of water vapour content on the plasters specimens, also in g/m^2, was evaluated at the same defined periods of time (from 1 up to 24 hours).

Results and discussion

Fresh state

The flow table consistency and wet bulk density of the mortars are presented in Table 3. For earth mortars, DIN 18947 [22] defines that the flow table consistency should be 175 ± 5 mm and the wet bulk density should be higher than 1.2 kg/dm^3. Earthen mortars, but also the remaining mortars, fulfilled the wet bulk density defined by DIN 18947 [22]. However, the flow table consistency was not accomplished for any mortars. The non-compliance is related to the water content used in the mortars mixture. For the earth mortars it was chosen to obtain a good workability, defined by the craftsman, with the aim of resembling the reality on a working site. The added water was the minimum to achieve good workability. The water content used on C mortar was the indicated by the producer. The flow table consistency of the G mortar was not evaluated due to the wall effect: the mortar in the fresh state was clinging to the truncated conical mould used in the test, being impossible to perform the test.

Table 3. Flow table consistency and wet bulk density of the mortars

Mortar	Flow table consistency [mm]	Wet bulk density [kg/dm^3]	Water/dry components ratio [-]
T_E	125 ± 8	2.03 ± 0.02	0.1
T_AP	136 ± 19	1.56 ± 0.06	0.1
T+CL	153 ± 1	1.99 ± 0.02	0.2
C	138 ± 14	1.90 ± 0.00	0.1
G	-	1.58 ± 0.05	0.4

Dry bulk density and strengths

Figure 4 reports the dry bulk density, flexural and compressive strength of the mortars. In general, earth mortars (T_E, T_AP and T+CL) present similar dry bulk density. The C mortar presents bulk density similar to earthen mortars and the G mortar present lower bulk density. These results can be justified by the bulk density of each material: all the materials presents similar loose bulk density (Table 1), with the exception of the gypsum material, which has the lowest loose bulk density and, consequently, lower dry bulk density.

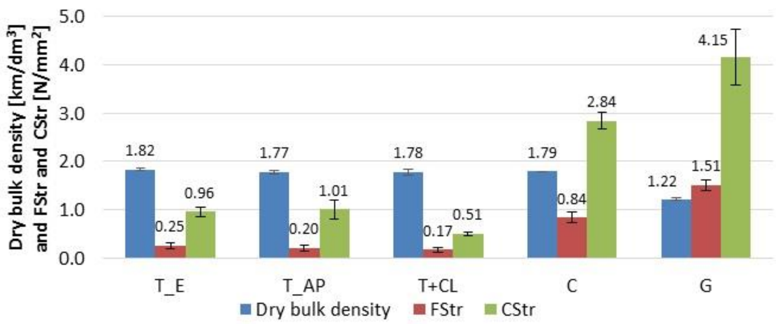

Figure 4. Dry bulk density and flexural (FStr) and compressive (CStr) strengths of the mortars.

Flexural and compressive strength of T+CL mortar were performed after 138 days – much aged in comparison to the remaining mortars (Table 2). Nevertheless, by Figure 4 it can be concluded that T+CL mortar present lower strengths, even when comparing with earth mortars without addition of any type of binder. This means that, in this case, the addition of air lime does not improve the mechanical strength of the mortar. One possibility for this result is if the carbonation reaction of the air lime has not been completed yet. Nevertheless, Santos et al. [17] concluded also that the addition of 5 %

of air lime decreased the mechanical strength of an earth mortar. Another study performed by Gomes et al. [29] have shown similar results with air lime additions up to 15 %. In these studies the justification given was that low amounts of lime interrupts the clay matrix connection, without creating a lime network strong enough to replace those clay connections. Although the content of air lime in the T+CL mortar is not known, the same phenomena may have happened.

The earthen mortars present lower mechanical strength compared to cement and gypsum mortars – which present values confirmed by previous studies: in a study with ancient gypsum-based plasters from the 18th – 20th centuries, Freire et al. [33] obtained compressive strength of 1.02 – 4.27 N/mm^2; Brás et al. [34], for cement mortar with CEM II B-L 32.5 N cement, obtained flexural strength of 5.2 N/mm^2 and compressive strength of 24.4 N/mm^2, at 28 days of age; Bogas et al. [35] analysed cement mortars with CEM I 42.5 R cement and obtained flexural strength of 6.7 N/mm^2 and compressive strength of 41.9 N/mm^2, at 28 days of age.

Veiga et al. [36] defined general requirements concerning some characteristics of plastering mortars for application on old buildings: flexural strength of 0.2 – 0.7 N/mm^2 and compressive strength of 0.4 – 2.5 N/mm^2. Unlike cement and gypsum mortars, earth mortars meet the flexural and compressive strength requirements and can be applied to repair old buildings. The EN 998-1 [37] defined different classes for compressive strength for plastering mortars: CSI for 0.4 – 2.5 N/mm^2; CSII for 1.5 – 5.0 N/mm^2; CSIII for 3.5 – 7.5 N/mm^2 and CSIV for ≥ 6 N/mm^2. The earth mortars analysed in the present study (T_E, T_AP and T+CL) can be classified as CSI and the cement mortar as CSII. The EN 13279 [38] defines that gypsum plasters must meet at least a flexural strength of 1 – 2 N/mm^2 and a compressive strength of 2 – 6 N/mm^2. The gypsum mortar analysed in the present study meets the minimum values defined by EN 13279 [38].

Capillary absorption and drying

Observing the capillary absorption curves of each mortar presented in Figure 5a it is possible to conclude that T+CL and C mortars have very similar behaviour. Similar values for capillary water absorption coefficient, 0.10 and 0.12 kg/(m^2.s$^{1/2}$), and also similar values in respect to the total quantity of water absorbed per unit area, 9.09 and 9.11 kg/m^2 (Figure 5b), are presented for T+CL and C, respectively. The capillary water absorption coefficients (AC) are show in Table 4 and it can be concluded that:

– T_E mortar presents slower capillary water absorption (Figure 5a) and, therefore, lower capillary coefficient; therefore, this mortar presents a good behaviour in a first contact with water. Nevertheless, it did not reach an asymptotic value; at the end of the test, this mortar was still absorbing water by capillarity. The behaviour of this mortar can be justified by the type of clayish earth, which may block the water ingress, slowing its absorption. This mortar seems to indicate water-repellence. To the authors knowledge water repellents were not added or at least that information was omitted by the producer.

– T_AP mortar presents high initial capillarity water absorption (Figure 5a), which is confirmed by the higher capillary coefficient when compared to the other mortars. This mortar presents the worst behaviour when subjected to the action of water by capillary absorption. This mortar also showed to be very sensitive to water and, after 210 minutes, mass loss occurred; for this reason the capillary test stopped before the remaining mortars.

– T+CL mortar present lower capillary water absorption in relation to the remaining earth mortars (T_E and T_AP). It seems that lime blocks the behaviour of clay. This behaviour, between clay and cement or lime, is documented and studied by Gomes et al. [39]. The researchers refer that clay has a different behaviour when it is mixed with lime – this binder acts as blocker of the clay structure, inhibiting the characteristics of the clay.

– Current pre-mixed mortars (C and G) have the same initial capillary water absorption behaviour – present the same slope of the linear section of the absorption curve (Figure 5a); the AC confirms this behaviour. Nonetheless, the G mortar has a greater capacity to absorb high amount of water by capillarity, with water absorbed per unit area of 14.8 kg/m^2 (Figure 5b). The higher capillary water absorption of the G mortar may be related to the higher fineness of the material and, possibly, higher porosity and pore size distribution [33]. In the present study, these conclusions cannot be established since porosity and pore size distribution could not be analysed yet. C and T+CL mortars present similar capillary water absorption behaviour, with similar capillary coefficient and asymptotic value.

The drying curves allowing to determine the first drying phase of each mortar can be observed in Figure 5b. The drying rates of first (D1) and second (D2) phases, and the drying index (ID) (at 420 hours approximately) are presented in Table 4. It is possible to conclude that:

– The T_E, T_AP and C mortars present similar drying behaviour and this is confirmed by drying rates and drying indexes. In global terms they present adequate drying, since they present high drying rate – ensuring fast initial drying – and low drying index – ensuring total drying capacity – in comparison with the remaining mortars.

– The T+CL mortar presents the worst drying behaviour, with low drying rates and high drying index. This behaviour may be justified by the presence of lime, that seems to contribute to significantly increase the capillary suction and decrease the drying capacity [39].

– G mortar presents the highest amount of water absorbed per unit area; so it is also the mortar that has more water to evaporate at the beginning of the test. Although it has a higher water content to evaporate, presents similar drying behaviour when compared to T_E, T_AP and C mortars; this is confirmed by drying rates results.

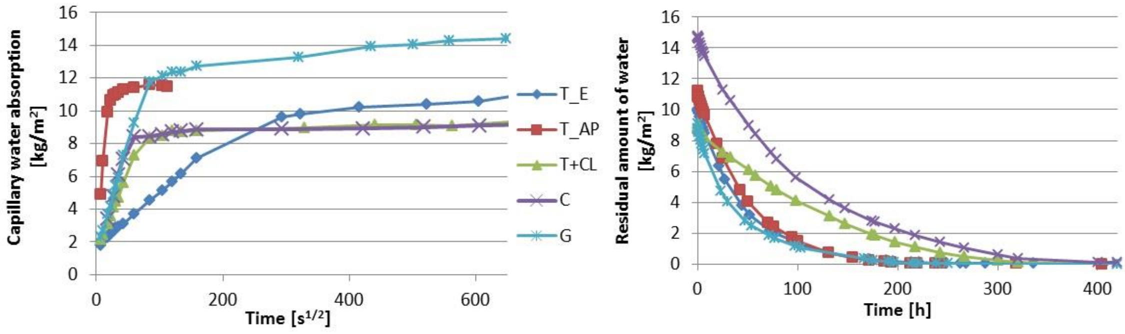

Figure 5. Capillary absorption (a) and drying (b) curves.

Table 4. Capillary water absorption coefficient, drying rate of first and second phase and drying index

Mortar	AC [$kg/m^2.s^{1/2}$]	D1 [$kg/m^2.h$]	D2 [$kg/m^2.h^{1/2}$]	ID [-]
T_E	0.03 ± 0.00	0.15 ± 0.01	1.11 ± 0.05	0.11 ± 0.01
T_AP	0.41 ± 0.06	0.15 ± 0.00	1.15 ± 0.03	0.12 ± 0.00
T+CL	0.10 ± 0.01	0.05 ± 0.00	0.44 ± 0.03	0.25 ± 0.03
C	0.12 ± 0.00	0.17 ± 0.01	1.03 ± 0.07	0.11 ± 0.03
G	0.14 ± 0.01	0.11 ± 0.01	0.91 ± 0.06	0.24 ± 0.01

AC – Capillary water absorption coefficient; D1 –Drying rate in the first phase; D2 – Drying rate in the second phase; ID – Drying Index.

Sorption and desorption

Figure 6 presents the results of the sorption and desorption of the plasters. In this figure the limits of sorption classes (WSI, WSII and WSIII) defined by DIN 18947 [22] are also presented. For earth plasters, DIN 18947 [22] defines three sorption classes: WSI for sorption ≥ 35 g/m^2; WSII for ≥ 47.5 g/m^2; WSIII for ≥ 60 g/m^2, after 12 hours.

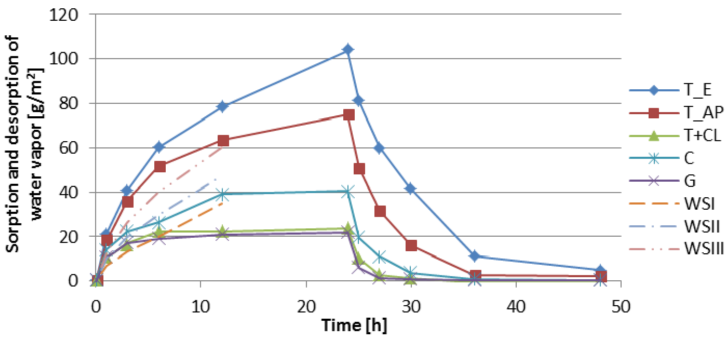

Figure 6. Sorption and desorption curves and sorption limits (WSI, WSII and WSIII) defined by DIN 18947 [22].

The results show that the earth plasters present significantly higher sorption and desorption capacity in comparison to all the plasters with common binders. The T_E and T_AP plasters can be classified in WSIII class, by DIN 18947 [22], since their sorption is higher than 60 g/m^2 of water vapour after 12 hours. The T_E plaster presents the higher sorption capacity having adsorbed about 104 g/m^2 after 24 hours. Despite the good water vapour sorption capacity demonstrated by the T_AP plaster, it only absorbs about 76 g/m^2 during the test. By observing the sorption curves (Figure 6), it is possible to conclude that T_E and T_AP plasters could adsorb a higher amount of water vapour since the sorption curves still show a growing trend at 24 hours. The high sorption capacity demonstrated by the T_E plaster may be related to the type of clay present in the plaster and/or the addition of natural fibres, since fibres increase the hygroscopicity of earth plasters [11].

By Figure 6 it is also possible to conclude that the addition of air lime decreases the sorption capacity of earth plasters. The T+CL plaster only adsorbed about 24 g/m^2 of water vapour during the 24 hours of the test. The low water vapour sorption capacity of this plaster may be related to the addition of air lime, but also to the type of clay used. Analysing DIN 18947 [22], the T+CL is impossible to classify, since at 12 hours this plaster presents a sorption lower than the limit for the lower class (WSI ≥ 35 g/m^2). Unlike earth plasters without mineral binders, the T+CL plaster presents stable adsorption behaviour after 6 hours of testing. It seems that lime blocks the behaviour of clayish particles, as previously mentioned.

The C and G plasters present lower sorption capacity in comparison with unstabilized earth plasters (T_E and T_AP). The sorption capacity of the C plaster is 40 g/m^2. The G and T+CL plasters present similar sorption behaviour.

Relative to desorption, all plasters present a good behaviour, having desorbed almost the entire water vapour that adsorbed. The T_E and T_AP plasters desorb a little less water vapour than they adsorbed, after 24 hours – they would probably reach the same initial values if there were more time to perform the test, since they show a downward trend. After performing the desorption test the remaining plasters present similar water vapour content in relation to 0 hours. This means that these plasters (T+CL, C and G) desorbed all the vapour water they have adsorbed in a similar period of time.

Conclusion

There are known complaints and discomfort felt by the occupants of the buildings which, through scientific evidence, are related, not only but also, with the building materials used indoors. It is increasingly important to be aware of the influence that building materials have on the health and comfort of inhabitants. Therefore, it is extremely important to study hygienic and human toxicological aspects, in order to ensure the existence of healthy, pleasant and comfortable environments. The INDEEd project intend to help answering these questions by attempting to quantify possible improvements that may be beneficial to indoor air quality presented by different types of earth-based plasters compared to other plasters commonly used in Portugal, based on gypsum and cement mortars.

It was verified, in the present study, that earthen mortars present lower mechanical strength when compared to mortars with current mineral binders (gypsum and cement). Also the addition of air lime to earth mortars seems to decrease their mechanical strength. On the other hand, it has been demonstrated that unstabilized earth plasters presents a high capacity of sorption and desorption, validating their ability to regulate RH and temperature. Therefore unstabilized earth plasters contribute to indoor comfort and, perhaps, the ability to capture indoor pollutants may be related with their sorption capacity. This capacity is being studied in the INDEEd project and will be reported in future work.

Acknowledgements

Acknowledgments are due to Aldeias de Pedra, Embarro, Secil Argamassas and Sival Companies for providing the materials and pre-mixed mortars. This study was funded by the Portuguese Foundation for Science and Technology through project INDEEd – Indoor air quality regulation through the usage of eco-efficient mortars (SAICT/23349/2016), by Operational Programme Competitiveness and Internationalization (COMPETE 2020) and by FEDER funds through the Regional Operational Program of Lisbon and of Center (Lisbon 2020, Center 2020).

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